UNITED STATES
DEPARTMENT
OF THE NAVY

NAVAL BASE
KITSAP BANGOR

SILVERDALE,
KITSAP COUNTY,
WASHINGTON

Prepared by:

JULY 2010

TEST PILE PROGRAM
NBK BANGOR WATERFRONT

DRAFT
ESSENTIAL FISH HABITAT ASSESSMENT

Quillback rockfish Photo credit: NOAA

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LIST OF ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
cm	Centimeters
CSL	Cleanup Screening Level
dB	Decibel
DO	Dissolved oxygen
EA	Environmental Assessment
EFH	Essential Fish Habitat
EHW	Explosives Handling Wharf
FMC	Fishery Management Council
FMP	Fishery Management Plan
FR	Federal Register
HAPC	Habitat Areas of Particular Concern
HUD	Habitat Use Database
km	Kilometers
m	Meters
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MHHW	Mean higher high water
MLLW	Mean lower low water
MRA	Marine Resources Assessment
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
Navy	United States Department of the Navy
NBK	Naval Base Kitsap
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
PAH	Polycyclic aromatic hydrocarbon
PFMC	Pacific Fishery Management Council
PSU	Practical salinity units

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

rms	Root mean square
SEL	Sound Exposure Level
SSP	Strategic Systems Programs
TOC	Total organic carbon
TRIDENT	TRIDENT Fleet Ballistic Missile Program
U.S.	United States
U.S.C.	United States Code

1.0 INTRODUCTION

As required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the purpose of this document is to present the findings of the Essential Fish Habitat (EFH) Assessment conducted for the United States (U.S.) Department of the Navy's (Navy) proposed Test Pile Program. The objective of this EFH Assessment is to evaluate how the actions proposed as part of the Test Pile Program may affect EFH designated by the Pacific Fishery Management Council (PFMC) and implemented by the National Marine Fisheries Service (NMFS) within its area of influence.

This EFH Assessment will include a description of the proposed action; an overview of the EFH designated within the activity area, an analysis of the direct and cumulative effects on EFH for the managed fish and their food resources; the Navy's views regarding the effects of the proposed activity; and proposed mitigation measures selected to minimize any potential adverse effects resulting from the proposed activity.

Additional detail regarding the Navy's proposed Test Pile Program, the affected environment, and the potential environmental effects associated with ongoing and proposed naval activities is contained in the Draft Environmental Assessment (EA) for the Test Pile Program - NBK Bangor Waterfront (July 2010). The Marine Resources Assessment (MRA) for the Pacific Northwest Operating Area (DoN 2006) also contains comprehensive descriptions of the marine environment including climate, marine geology, physical, chemical, and biological oceanography, marine habitats, and protected species in the project site.

2.0 PROPOSED ACTION

The Naval Base Kitsap (NBK) Bangor is situated adjacent to the Hood Canal in Kitsap County in the town of Bangor, Washington approximately 20 miles (32 kilometers [km]) west of Seattle (Figure 2–1). The NBK Bangor provides berthing and support services to Navy submarines and other fleet assets. The entirety of NBK Bangor, including the land areas and adjacent water areas in Hood Canal, is restricted from general public access.

As part of the Navy's sea-based strategic deterrence mission, the Navy Strategic Systems Programs (SSP) directs research, development, manufacturing, test, evaluation, and operational support of the TRIDENT Fleet Ballistic Missile (TRIDENT) Program. As part of this mission, SSP is proposing to construct and operate a second Explosives Handling Wharf (EHW-2) adjacent to the existing Explosive Handling Wharf at NBK Bangor. The proposed EHW-2 is needed to ensure the Navy has in place the facilities required to load and offload missiles and to perform routine operations and upgrades necessary to maintain the TRIDENT Program. To inform the design of the proposed EHW-2, the Navy is proposing to conduct a study to test

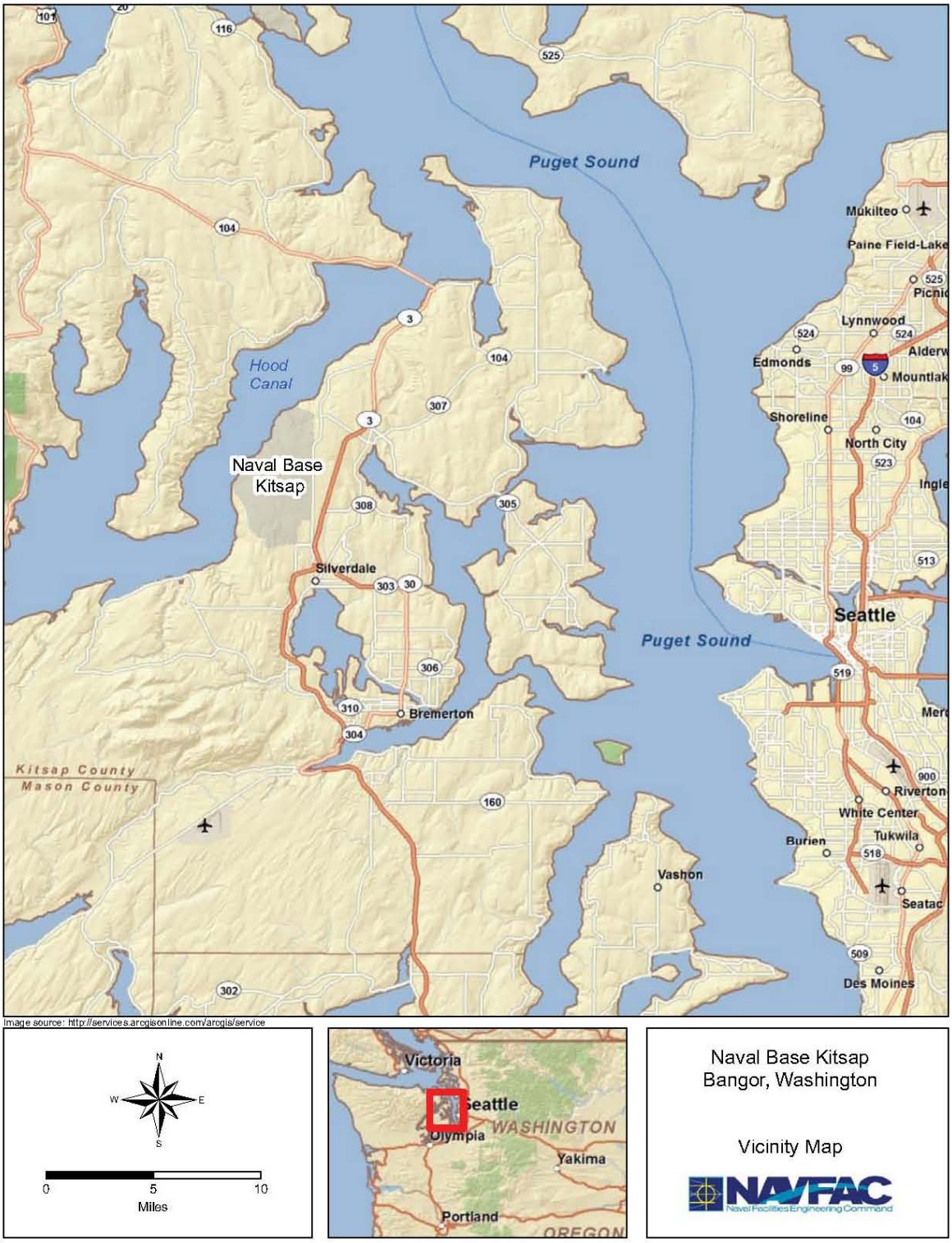

Figure 2-1. Location of Naval Base Kitsap in Bangor, WA.

various types of piles. The proposed action (also called the Test Pile Program) is to install and remove up to 29 test and reaction piles, conduct testing on select piles, and measure in-water noise propagation during pile installation and removal. Geotechnical and noise data collected during pile installation and removal will be integrated into the design, construction, and environmental planning for the Navy's proposed EHW-2. The Navy proposes to install the test piles in the location planned for the proposed EHW-2 (south of the existing Explosives Handling Wharf; Figure 2-2); however, other future projects can also benefit from the geotechnical and noise propagation data gathered from driving the test piles.

The Test Pile Program will involve driving 18 hollow steel piles, ranging in size from 30 to 60 inches (76.2 to 152.4 centimeters [cm]) in diameter and having a thickness of 0.75 inches (1.9 cm), at predetermined locations within the proposed footprint of EHW-2 (Figure 2-3). Eleven additional reaction piles will be installed to perform lateral load and tension load tests on the original 18 test piles. The test and reaction piles will range in length from 100 to 197 feet (30.5 to 60 meters [m]) and will be placed in water depths of 10 to 100 feet (3 to 30.5 m). All piles will be vibratory driven for their initial embedment depths and then will be impact driven for their final 10 to 15 feet (3 to 4.6 m). However, piles meeting excessive resistance using the vibratory hammer will be impact driven to the design depth. Noise attenuation measures will be used during all impact hammer operations and the vibratory hammer operations for at least two of the piles. The proposed action would also cover the removal of all test piles at the completion of the program through the use of vibratory hammers. Hydroacoustic monitoring will be performed to assess the effectiveness of the noise attenuation measures. The entire Test Pile Program will not exceed more than 40 days in duration.

3.0 ESSENTIAL FISH HABITAT

In 1996, the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (Public Law 104-267). The reauthorized MSFCMA mandated numerous changes to the existing legislation designed to prevent overfishing, rebuild depleted fish stocks, minimize bycatch, enhance research, improve monitoring, and protect fish habitat. One of the most significant mandates in the MSFCMA that came out of the reauthorization was the EFH provision, which provides the means to conserve fish habitat.

The EFH mandate requires that the regional fishery management councils (FMCs), through federal fishery management plans (FMPs), describe and identify EFH for each federally managed species; minimize, to the extent practicable, adverse effects on such habitat caused by fishing; and identify other actions to encourage the conservation and enhancement of such habitats. Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 United States Code [U.S.C.] 1802[10]). The term "fish" is defined in the MSFCMA as "finfish, mollusks, crustaceans, and all other forms of

Figure 2-2. The location of the action area in relation to the existing Explosive Handling Wharf.

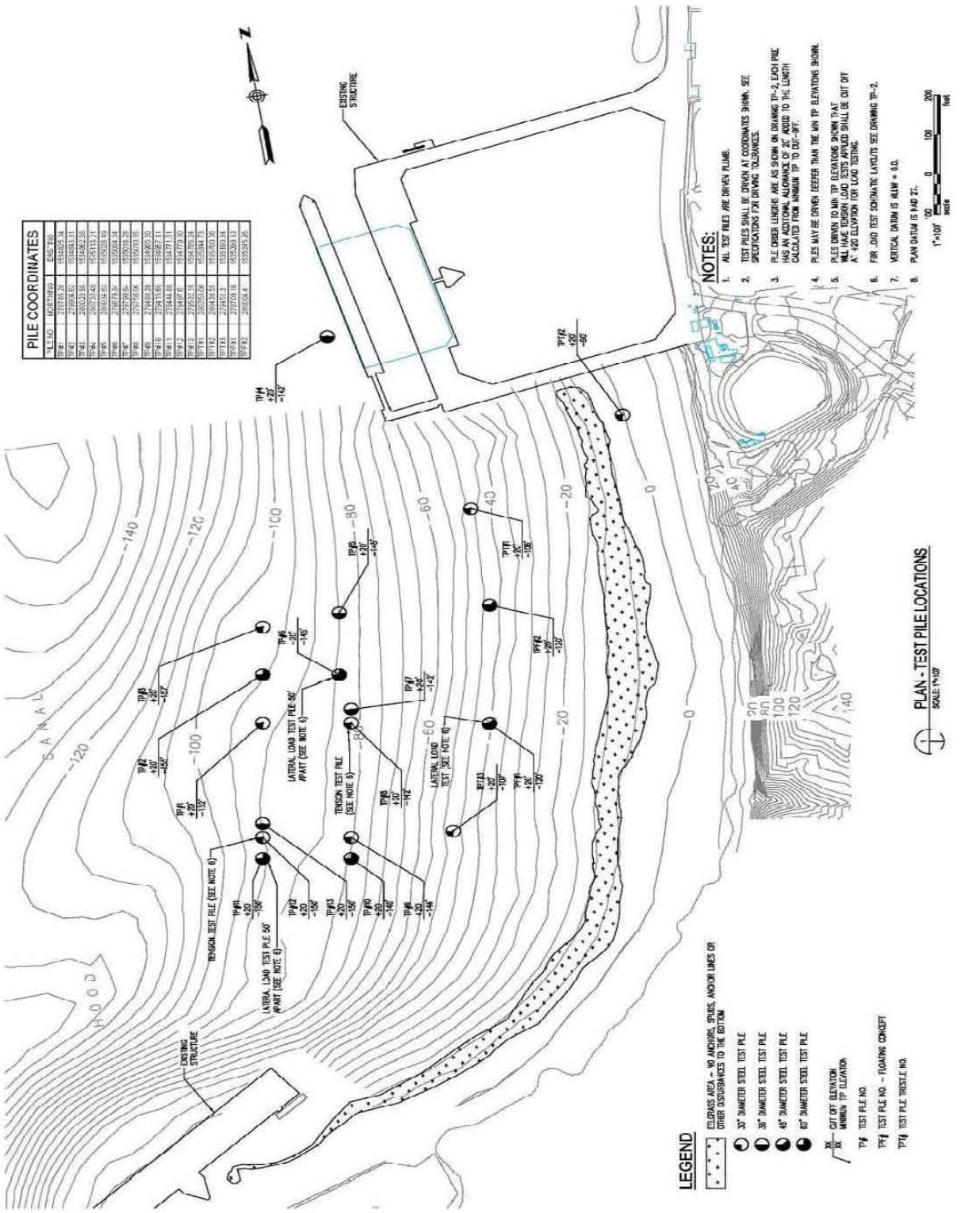

Figure 2-3. A depiction of the planned locations of the piles to be tested during the Test Pile Study in relation to the existing Explosives Handling Wharf at NBK Bangor.

marine animals and plant life other than marine mammals and birds." The regulations for implementing EFH clarify that "waters" include all aquatic areas and their biological, chemical, and physical properties, while "substrate" includes the associated biological communities that make these areas suitable fish habitats (50 Code of Federal Regulations [CFR] 600.10). Habitats used at any time during a species' life cycle (i.e., during at least one of its lifestages) must be accounted for when describing and identifying EFH (NMFS 2002).

Authority to implement the MSFCMA is given to the Secretary of Commerce through the NMFS. The MSFCMA requires that EFH be identified and described for each federally managed species. The MSFCMA also requires federal agencies to consult with the NMFS on activities that may adversely affect EFH or when the NMFS independently learns of a federal activity that may adversely affect EFH. The MSFCMA defines an adverse effect as "any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810).

In addition to EFH designations, areas called Habitat Areas of Particular Concern (HAPC) are also designated by the regional FMCs. Designated HAPC are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation (50 CFR 600.805-600.815). Regional FMCs may designate a specific habitat area as an HAPC based on one or more of the following reasons: 1) importance of the ecological function provided by the habitat; 2) the extent to which the habitat is sensitive to human-induced environmental degradation; 3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and 4) rarity of the habitat type (NMFS 2002). Categorization as HAPC does not confer additional protection or restriction to the designated area.

This EFH Assessment analyzes the potential effects of Navy activities to fish and EFH in the context of the MSFCMA. To help identify Navy activities falling within the adverse effect definition for EFH, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH. The EFH Final Rule (67 Federal Register [FR] 2354) and 50 CFR 600.815(a)(2)(ii) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, as opposed to those activities resulting in inconsequential changes to habitat. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions (NMFS 2002). While these criteria were established to pertain to fishing activities, in the absence of similar criteria/guidance for non-fishing impacts on EFH and pursuant to the preamble of the EFH Final

Rule which states that "Federal agencies retain the discretion to make their own determinations as to what actions may fall within NMFS' definition of 'adverse effect'" (67 FR 2347), it is the policy of the Navy that these same criteria are to be used for determining whether the Navy's non-fishing impacts reduce the quality and/or quantity of EFH (i.e., fall within the adverse effect definition) (OPNAVINST 5090.1B).

3.1 ESSENTIAL FISH HABITAT DESIGNATIONS

The PFMC is responsible for designating EFH for all federally managed species occurring in the coastal and marine waters off the coasts of Washington, Oregon, and California, including the Puget Sound. The PFMC designated EFH for these species within the FMPs for each of the four primary fisheries that they manage: Pacific Coast Groundfish, Pacific Coast Salmon, Coastal Pelagic Species, and West Coast Fisheries for Highly Migratory Species (PFMC 1998, 2003, 2007, 2008). Of these fisheries, only three (groundfish, salmon, and coastal pelagic species) contain species for which EFH has been designated within the Hood Canal or in the vicinity of NBK Bangor.

3.1.1 Groundfish

Pacific coast groundfish species are considered sensitive to over-fishing, the loss of habitat, and water and sediment quality (PFMC 2008). The groundfish EFH consists of the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem (PFMC 2008). The PFMC (2008) identifies the overall area designated as groundfish EFH for all species covered in the FMP as all waters and substrate within "depths less than or equal to 3,500 m [~ 11,500 feet] to mean higher high water level (MHHW) or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow." Furthermore, the PMFC (2008) has also designated EFH for each individual groundfish species by lifestage. These designations are contained within Appendix B of the FMP. Using the Pacific Habitat Use Relational Database (HUD) developed by the PFMC, it was determined which groundfish species and lifestages have EFH designated within the vicinity of the Test Pile Program site. A table of these species/lifestages is contained within the Appendix of this EFH Assessment. The management unit in the Pacific Coast Groundfish FMP includes 83 groundfish species (PFMC 2008). Of these, 32 were identified through the analysis of the HUD as having EFH designated in the vicinity of NBK Bangor. Based on the analysis, the primary habitats designated as EFH for these species include:

- The epipelagic zone of the water column, including macrophyte canopies and drift algae;
- Unconsolidated sediments consisting of mud, sand, or mixed mud/sand;
- Hard bottom habitats composed of boulders, bedrock, cobble, gravel, or mixed gravel/cobble;

- Mixed sediments composed of sand and rocks; and
- Vegetated bottoms consisting of algal beds, macrophytes, or rooted vascular plants.

3.1.2 Salmon

The salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters of Washington, Oregon, and California north of Point Conception out to the exclusive economic zone (200 miles) offshore (PFMC 2003). In addition to the marine and estuarine waters, salmon species have a defined freshwater EFH, which includes all lakes, streams, ponds, rivers, wetlands, and other bodies of water that have been historically accessible to salmon (PFMC 2003), including the waters of NBK Bangor. For the Pacific salmon fishery, EFH (which includes Hood Canal), is identified using U.S. Geological Survey (USGS) hydrologic units, as well as habitat association tables and life history descriptions of each life stage (PFMC 2003). Pacific salmon species EFH is primarily affected by the loss of suitable spawning habitat, barriers to fish migration (habitat access), reduction in water and sediment quality, changes in estuarine hydrology, and decreases in prey food source (PFMC 2003).

3.1.3 Coastal Pelagic Species

The EFH designations for coastal pelagic species are based on the geographic range and in-water temperatures where these species are present during a particular life stage (PFMC 1998). Specific EFH boundaries (i.e., the habitat necessary to provide sufficient fishery production) are based on best available scientific information and described in the Coastal Pelagics Fishery Management Plan (PFMC 1998). These boundaries include the waters of NBK Bangor. Two species identified as coastal pelagic species are known to occur in Hood Canal waters: northern anchovy and market squid (SAIC 2006; Bhuthimethee et al. 2009). Aside from their value to commercial Pacific fisheries, coastal pelagic species are also recognized for their importance as food for other fish, marine mammals, and birds (63 FR 13833). Coastal pelagic species are considered sensitive to overfishing, the loss of habitat, reduction in water and sediment quality, and changes in marine hydrology, including entrainment through water intakes (PFMC 1998). The primary threats to the proposed krill EFH have not yet been defined by NMFS.

3.2 HABITAT AREAS OF PARTICULAR CONCERN DESIGNATIONS

In addition to designating EFH, the PMFC is also responsible for identifying HAPC for federally managed species. Out of the four fisheries managed by the PFMC, HAPC has only been identified for groundfish. The four HAPC designated for these species include seagrass, canopy kelp, rocky reef, and estuarine habitats along the Pacific coast, including Puget Sound. Two of these HAPC, estuarine habitats and seagrass, are located within the vicinity of the Test Pile Program site.

3.3 DESCRIPTIONS OF HABITATS

3.3.1 Water Column

The values for several of water quality parameters (temperature, salinity, dissolved oxygen [DO], and turbidity) that were measured at a series of shallow, nearshore, and deeper, offshore sampling locations along the NBK Bangor waterfront in 2005 and 2006 (Phillips et al. 2009). The sampling stations include locations near the proposed project site (Figure 3-1). Water quality at NBK Bangor is good by most measures and meets applicable standards. Although DO is low in much of Hood Canal, this problem is less pronounced in northern Hood Canal, the location of NBK Bangor, than elsewhere in the canal. At NBK Bangor, DO almost always meets standards in nearshore waters including within the proposed project site.

3.2.1.1 Stratification, Salinity, and Temperature

The waters of Hood Canal surrounding the new EHW project site are stratified, with less saline, warmer water overlying colder, more saline bottom waters. The salinity of the upper water layer is sensitive to the amount of freshwater input and may become more diluted during heavy precipitation (URS Consultants, Inc. 1994). Variances due to seasonal changes (such as freshwater input, wind-induced mixing, and solar heating) are common (URS Consultants, Inc. 1994).

Freshwater input into Hood Canal comes from creeks, rivers, groundwater (including artesian wells [deep underground aquifer]), and stormwater outfalls. The freshwater inputs affect the salinity in Hood Canal. Artesian wells also contribute to freshwater inputs, with estimated flows of 2,000 to 2,500 gallons per minute (WDOE 1981). Overland flow from much of the western portion of NBK Bangor is routed to Hood Canal through a series of stormwater outfalls. Saltwater and freshwater mixing zones exist at the mouths of each of these streams and outfalls (URS Consultants, Inc. 1994).

Between June 2005 and July 2006, surface water salinity levels along the NBK Bangor waterfront ranged from 26 to 35 practical salinity units (PSU) (Phillips et al. 2009). Salinity measurements with depth reflected a stratified water column, with less saline surface water overlying cooler saline water at depth. The transition between the lower salinity surface waters and higher salinity subsurface waters occurred at a depth of about 33 feet (Phillips et al. 2009). The lowest surface water salinity (26.7 PSU) was measured in January 2006 when input from fresh water may have been high due to winter storms and runoff. The range of salinity along the NBK Bangor waterfront is typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

Figure 3-1. Water quality monitoring stations at the site of the proposed Test Pile Program at Naval Base Kitsap Bangor (Phillips et al. 2009).

The temperature of marine surface waters designated as extraordinary quality should average less than 13.0°C (55ºF), or 0.3°C (0.5ºF) above natural levels (WAC 173-201A). Temperatures for the nearshore locations (water depth ranging from 1 to 60 m) met extraordinary quality standards during the winter months (January to May 2006) and excellent quality standards during the summer months (July to September 2005 and June 2006). Nearshore areas are susceptible to greater temperature variations due to seasonal fluxes in solar radiation input. Water temperatures at the offshore locations (water depths ranging from 20 to 60 meters) met extraordinary quality standards in July 2005, September 2005, and March through May 2006 and excellent quality standards during late summer (August).

3.3.1.2 Dissolved Oxygen

Data from the Washington State Department of Ecology's Marine Water Quality Monitoring Program for 1998 to 2000 and the Hood Canal Dissolved Oxygen Program for 2002 to 2004 show that Hood Canal is particularly susceptible to low DO levels (Newton et al. 2002; HCDOP 2005). The NBK Bangor and the proposed project site are located along the northern stretch of Hood Canal, which is less affected by these seasonal episodes of low DO. From 2003 through 2008, DO concentrations in Hood Canal off the southern boundary of NBK Bangor ranged from approximately 3.8 to 11.8 milligrams per liter (mg/L) at depths of 33 feet (HCDOP 2009). For this same time period, DO concentrations in surface waters ranged from approximately 5 to 13.8 mg/L. The concentrations fluctuate seasonally, with higher DO concentration in the spring and early summer and lower DO concentrations in late summer and fall. The lowest concentration during this period occurred during October 2006.

Mean DO measurements during July 2005 through June 2006 indicate that nearshore stations at the NBK Bangor waterfront consistently met extraordinary quality standards for DO. However, at offshore stations, these ratings ranged from fair to extraordinary quality standards (Phillips et al. 2009). These measurements are on the upper range of DO conditions measured historically throughout Hood Canal during the late summer and fall periods (Warner 2007).

3.3.1.3 Turbidity

Turbidity is a measure of the amount of light scatter related to total suspended solids in the water column and is measured in Nephelometric Turbidity Units (NTUs). Sources of turbidity in Hood Canal waters may include plankton, organic detritus from streams and other storm or wastewater sources, fine suspended sediment particulates (silts and clays), and re-suspended bottom sediments and organic particulates. Suspended particles in the water have the ability to absorb heat in the sunlight, which then raises water temperature and reduces light available for photosynthesis.

Washington State-designated extraordinary quality marine surface waters should have an average turbidity reading of less than 5 NTUs (WAC 173-201A). Turbidity measurements were

collected along the NBK waterfront, including in the vicinity of the proposed project site, from July 2005 through May 2006, except for October to December 2005 (Phillips et al. 2009). These mean monthly turbidity measurements for both nearshore and offshore waters ranged from 0.7 to 3 NTU and were consistently within the Washington State standards for extraordinary water quality.

3.3.2 Sediments

Sediment supply, distribution, deposition and erosion rates, grain size, organic content, and chemistry are all critical factors that determine the presence or absence of marine plants and animals at specific locations. Existing sediment information for NBK Bangor is based on results from sampling at the project site during 2007 (Hammermeister and Hafner 2009); sampling locations are shown in Figure 3-2. Sediment quality at the project site is generally good; levels of contaminants meet applicable state standards.

3.3.2.1 Physical and Chemical Properties of Sediments

The marine sediments at BNK Bangor are composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone (Hammermeister and Hafner 2009). Subsurface coring studies conducted in 1994 found the presence of glacial till approximately 6 feet below mud line in the intertidal zone, increasing to over 10 feet in the subtidal zone (URS Consultants, Inc. 1994). The composition of sediment samples from the project site ranged from 65 to 100 percent for sand, less than 1 to 7 percent for gravel, 2 to 32 percent silt, and 2 to 11 percent clay.

Sediment parameters (such as total organic carbon [TOC], metals, and organic contaminants) were used to characterize sediment quality. TOC, which provides a measure of how much organic matter occurs in the sediments, was less than 1 percent at the project site. A range of 0.5 to 3 percent is typical for Puget Sound marine sediments, particularly those in the main basin and in the central portions of urban bays (PSWQAT and PSEP 1997). Total sulfide concentrations range from not detected (i.e., below the detection limit of 0.4 milligrams per kilogram [mg/kg]) to 82.6 mg/kg. Ammonia concentrations range from 1.3 to 6.2 mg/kg. There are no sediment quality standards (SQS) for TOC, sulfides, or ammonia concentrations.

3.3.2.2 Metals

Concentrations of metals in the sediments at the proposed project site are comparable to background levels for Puget Sound and fall below sediment quality guidelines (e.g., SQS values and Cleanup Screening Level [CSL] values) established by the Washington State Sediment Management Standards (Hammermeister and Hafner 2009). For example, cadmium concentrations ranged from less than 0.1 to 0.3 mg/kg, which were below the standards of 5.1 and 6.7 mg/kg for SQS and CSL, respectively.

Figure 3-2. Sediment sampling locations at the site of the proposed Test Pile Program at Naval Base Kitsap Bangor (Hammermeister and Hafner 2009).

3.3.2.3 Organic Contaminants

The primary source of organotin (butyltin) compounds in marine sediments is residues from anti-fouling paints applied to vessel hulls (Danish EPA 1999). Use of organotins in anti-fouling paints for ships less than 82 feet (25 m) in length and non-aluminum hulls was banned in 1988 by the Organotin Anti-Fouling Paint Control Act. Organotin concentrations within the sediments at the proposed project site contain tri-n-butyltin concentrations up to 7.5 micrograms per kilogram (µg/kg) or 870 µg/kg TOC. While there is no existing sediment quality standard for organotins, Meador et al. (2002) proposed a threshold value of 6,000 µg/kg TOC for tributyltin in sediments as protective of juvenile salmonids. Thus, concentrations in sediments near the proposed project site are below this threshold.

Concentrations of individual polycyclic aromatic hydrocarbon (PAH) compounds in sediments near the proposed project site varied from not detected to 10 mg/kg TOC (Hammermeister and Hafner 2009). Concentrations of individual PAH compounds, as well as the summed concentrations, were below the corresponding SQS and CSL values.

Concentrations of other classes of organic contaminants, such as chlorinated aromatics, phthalate esters, phenols, and other miscellaneous extractable compounds, typically were at or below the analytical detection limits and consistently below the SQS and CSL values.

3.3.3 Benthic Communities

Benthic invertebrates are comprised of bottom dwelling animals that live burrowing or buried in the soft sediments (infauna) and those that live attached to hard bottom substrates (epifauna). Four major groups (Phylum) are found in Hood Canal and in the vicinity of the proposed project site: 1) marine worms (Annelids); 2) snails and bivalves (Molluscs); 3) crabs and other crustaceans (Arthropods); and 4) seastars and sea urchins (Echinoderms).

A recent survey of four different areas along the NBK Bangor waterfront found consistently greater benthic community development in the subtidal zone compared to the intertidal zone and variable community development within and among survey areas (Weston 2006). A mean total of 2 to 12 species with a mean total abundance of 3 to 67 individuals per square foot (0.10 m^2) was observed in the intertidal zone. Subtidal values varied from a mean total of 36 to 77 species and a mean total abundance of 301 to 736 individuals per square foot (0.10 m^2).

The soft-bottom benthic community within the vicinity of the proposed project site is dominated by marine worms, crustaceans, and molluscs across the tide zone, although in the intertidal zone other organisms also may be numerically abundant (Weston 2006; WDOE 2007).

3.3.4 Marine Vegetation

Marine vegetation within the NBK Bangor waterfront includes eelgrass, kelp, and green, red, and brown algae. Marine vegetation in the vicinity of the proposed project site includes primarily

eelgrass, kelp (including *Laminaria* sp.), and green and red algae. Most forms of macroalgae were documented in the shallow subtidal zone between 0 and 10 feet below MLLW, often growing in the direct presence of eelgrass (Morris et al. 2009).

3.3.4.1 Eelgrass

One of the most important marine vegetation types to the marine ecosystem is eelgrass. Eelgrass beds produce large amounts of carbon that fuel nearshore food webs. This environment offers habitat to various lifestages of many marine species. Shellfish, such as crabs and bivalves, use eelgrass beds for habitat and nursery areas. Eelgrass is critical habitat for juvenile salmonids, which use eelgrass beds as migratory corridors, for protection from predators, and for foraging (Mumford 2007). Well-established eelgrass beds were documented in 2007 in all survey areas along the NBK Bangor shoreline in shallow water depths ranging from 0 to 20 feet below the mean lower low water (MLLW) line (Morris et al. 2009). A dense band of eelgrass covering approximately 0.5 acre occurs in the inshore area of the existing Explosives Handling Wharf from MLLW to 5 feet below MLLW (Figure 3-3) (Morris et al. 2009). South of the existing Explosives Handling Wharf, a 2,400-foot (723-m) long, 3.3-acre (13,355-m^2) continuous eelgrass bed occurs below the MLLW line to a depth of -10 feet MLLW (Morris et al. 2009).

3.3.4.2 Kelp

Understory kelp (*Laminaria* sp.) provide a large source of photosynthesized nutrients to the seafloor (from fragmentation and decomposition) and important multi-species vertical habitat in deeper marine waters (Mumford 2007). Two narrow bands of understory kelp occur in the vicinity of the proposed project site approximately 330 feet (100 m) to the south of the existing Explosives Handling Wharf and shoreward of the existing Explosives Handling Wharf between the entrance and exit trestles (Figure 3-4). This species occurs in the subtidal zone. The southern band is approximately 1,600 feet (488 m) long and covers 2.3 acres (9,308 m^2). The northern band behind the existing Explosives Handling Wharf extends to the north covering 4,300 feet (1,311 m) and covering over 13.8 acres (56,250 m^2). No attached, canopy-forming kelp beds (e.g., bull kelp) occur at the proposed project site (Morris et al. 2009).

3.3.4.3 Macroalgae

Sea lettuce is the most common green algae at the new EHW project site. It grows from the lower-intertidal subzone to depths of more than 50 feet (15 m) below MLLW in protected areas along the waterfront (Figure 3-4) (Pentec 2003; Morris et al. 2009). Boulders in the nearshore marine habitats at the proposed project site are typically encrusted with sea lettuce (Pentec 2003). Sea lettuce has a high nutrient value (Kirby 2001) and provides an important source of marine nitrogen, as detritus, that supports eelgrass growth.

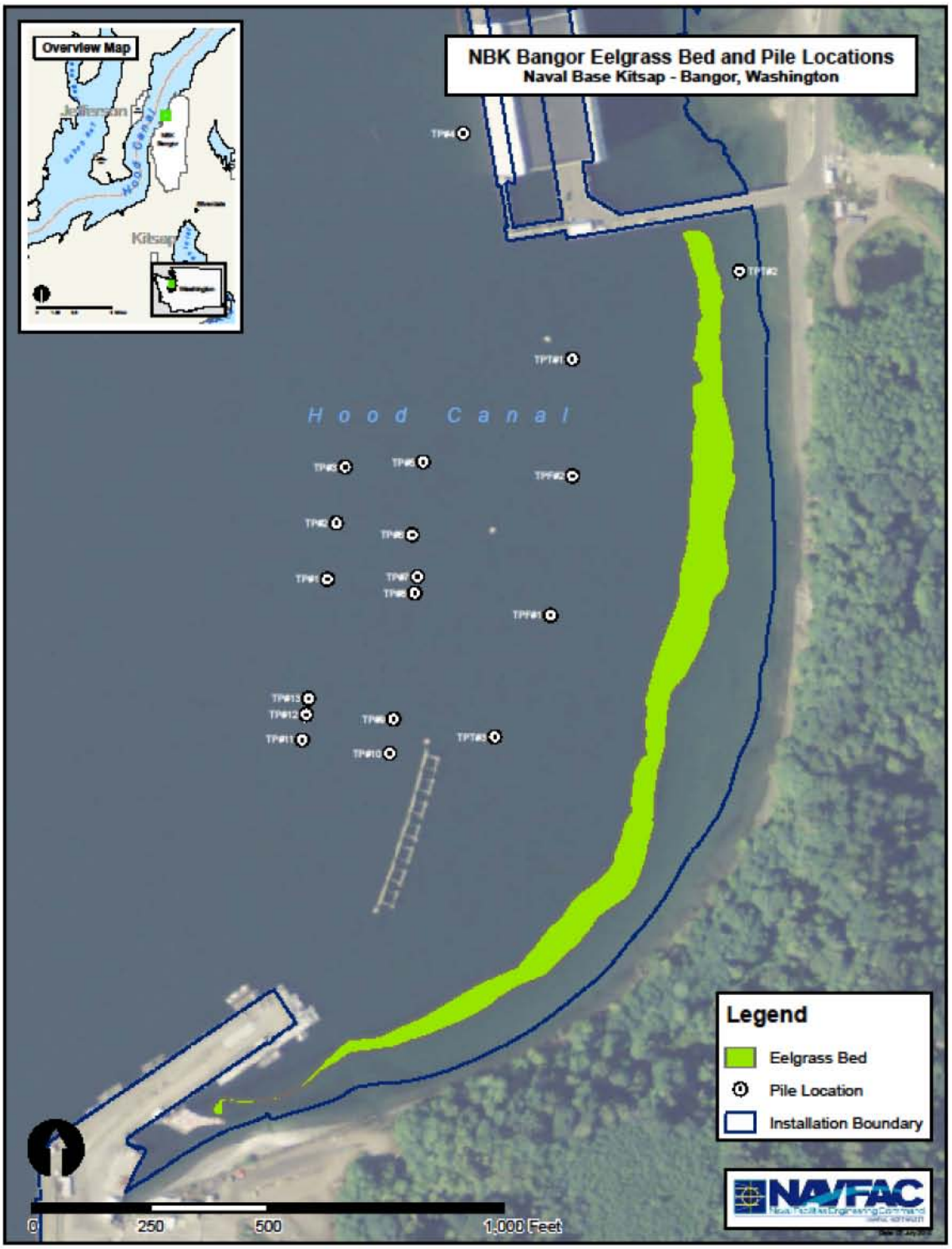

Figure 3-3. Eelgrass bed at Naval Base Kitsap Bangor in relation to location of the piles to be driven as part of the proposed Test Pile Program.

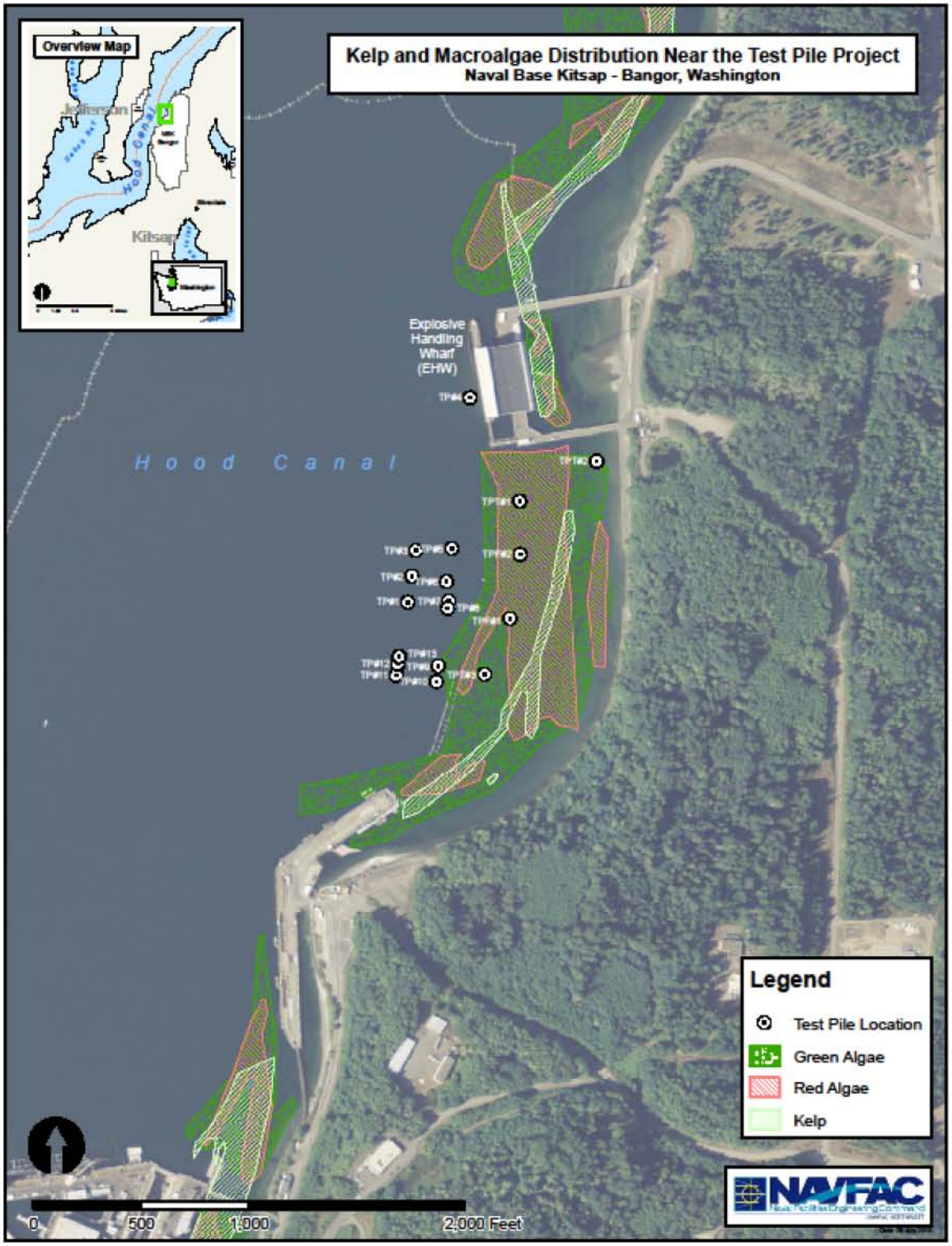

Figure 3-4. Kelp and algae beds at Naval Base Kitsap Bangor in relation to location of the piles to be driven as part of the proposed Test Pile Program.

Red algae of the genera *Endocladia*, *Mastocarpus*, *Ceramium*, *Porphyra*, and *Gracilaria* are present at the proposed project site in the intertidal zones (Pentec 2003) (Figure 3-4). During the 2007 survey, red algae (primarily *Gracilaria*) became more abundant at water depths between 10 feet (3 m) and 25 feet (7.6 m) below MLLW but also occurred out to depths of 60 feet (18 m) below MLLW (Morris et al. 2009).

Brown algae are found in a variety of forms, including encrusting varieties on rocks and boulders, filaments, and drift kelp. Understory kelp (*Laminaria* sp.) are a form of brown algae and were discussed above. Several leafy brown algae species (e.g., *Egregia*) are present in the vicinity of the proposed project site. Rock weed (*Fucus* spp.) is common, attached to rocks and cobble in the intertidal barnacle zone.

4.0 ASSESSMENT OF IMPACTS AND MITIGATION MEASURES

This section will examine the potential impacts to EFH and federally managed species. Identifiable impacts generated by the proposed Test Pile Program on each component of designated EFH are described, as are any potential environmental consequences of those impacts. In addition, measures taken by the Navy to prevent or minimize any potential impacts to EFH are presented.

4.1 IMPACTS TO ESSENTIAL FISH HABITAT

The evaluation of impacts to marine fish and their habitat is based on whether the species or fishery has particular sensitivity to the proposed action's activities and/or a substantial or important component of the species or fishery's habitat would be lost as a result of the implementation of the proposed Test Pile Program.

The greatest impact during Test Pile Program would occur while the piles are being driven. Pile driving would exceed the underwater noise thresholds for fish, established for both behavior and injury, and result in the greatest potential for adverse impacts to marine fish. Positioning and anchoring the construction barges and pile driving unit would locally increase turbidity, disturb benthic habitats and forage fish, and shade marine vegetation in the immediate project vicinity. Project related impacts to salmonid populations, which includes ESA-listed species, would be minimized by adhering to the in-water work period designated for northern Hood Canal waters, when less than five percent of all salmonids that occur in NBK Bangor nearshore waters are expected to be present (SAIC 2006). Mitigation measures to reduce the presence of ESA-listed and other fish during installation and removal of piles and observance of the in-water work window would reduce impacts.

4.1.1 Sound Levels

Pile driving would result in increased underwater noise levels in Hood Canal. As many fish use their swim bladders for buoyancy, they are susceptible to rapid expansion/decompression due to peak pressure waves from underwater noises (Hastings and Popper 2005). At a sufficient level this exposure can be fatal. Recently, underwater noise effects criteria for fish were revised and accepted for in-water projects following a multi-agency agreement (FHWG 2008).

For impact pile driving, the underwater noise threshold criteria for fish injury from a single pile strike occurs at a sound pressure level of 206 decibel (dB) peak pressure within a circle centered at the location of the driven pile out to a distance of approximately 13 feet (4 m) assuming properly functioning sound attenuation devices (e.g., bubble curtains) are used (10 dB reduction included for this distance). However, as the impact hammer driven piles for this project would likely require an average of approximately 100 strikes each, the approach requires using Sound Exposure Level (SEL) as the threshold. Therefore, the applicable criteria for injury from impact pile driving to fish would be 187 dB accumulated SEL for a fish greater than or equal to 2 grams in weight within a circle centered at the location of the driven pile out to a distance of approximately 112 feet (34 m) and 183 dB accumulated SEL for fish less than 2 grams in weight within a circle centered at the location of the driven pile out to a distance of approximately 207 feet (63 m) assuming properly functioning sound attenuation devices are used (10 dB reduction included for these distances) (FHWG 2008) (Figure 4-1).

Table 4-1. Interim criteria (FHWG 2008) and distance to effect for fish.

Effect	Criteria	Distance (meters) to Effect for Impact Hammer	Distance (meters) to Effect for Vibratory Pile Driving
Onset of Injury for all fish	Peak 206 dB	4	N/A
Onset of Injury for fish < 2 grams	Cumulative SEL 187 dB	34	N/A
Onset of Injury for fish ≥ 2 grams	Cumulative SEL 183 dB	63	N/A
Extent of behavioral impacts[1]	150 dB rms	2,154	1,000

[1] Behaviorial criteria was not set forth by the Fisheries Hydroacoustic Working Group, so as a conservative measure, the NMFS and the U.S. Fish and Wildlife Service generally use 150 dB rms as the threshold for behavioral effects to ESA-listed fish species (salmon and bull trout) form most biological opinions evaluating pile driving, however there are currently no research or data to support this threshold.

During pile driving, the associated underwater noise levels would result in behavioral response, including avoidance of the project area, and would have the potential to cause injury. Average underwater baseline noise levels acquired along the NBK Bangor waterfront were measured at a level of 114 dB re 1µPa (Slater 2009). Sound during impact pile driving would be detected above the average background noise levels at any nearby location in Hood Canal with a direct acoustic path (e.g., line-of-sight from the driven pile to the receiver location). The 150 dB root mean square (rms) re 1µPa behavioral threshold would be exceeded within a circle centered at the location of the impact driven pile out to a distance of approximately 1.34 miles (2.15 km) (in a direct line-of-sight manner) assuming properly functioning sound attenuation devices are used (10 dB reduction included for this distance). The affected area includes most of the NBK Bangor waterfront and portions of the Toandos Peninsula shoreline (Figure 4-1). Locations beyond these points would receive lower noise levels because an interposing land mass would impede propagation of the sound.

Fish in the project area may display a startle response during initial stages of pile driving, and would likely avoid the immediate project vicinity during pile driving activities. However, field investigations of Puget Sound salmonid behavior, when occurring near pile driving projects (Feist 1991; Feist et al. 1992), found little evidence that normally nearshore migrating salmonids move further offshore to avoid the general project area. In fact, some studies indicate that construction site behavioral responses, including site avoidance, may be as strongly tied to visual stimuli as to underwater sound (Feist 1991; Feist et al. 1992). Therefore, it could be assumed that salmonids may alter their normal behavior, including startle response and avoidance of the immediate project site, but occurrence within most of the 1.34 miles (2.15 km) disturbance area would not change.

To further minimize the underwater noise impacts during pile driving, a vibratory driver would be used whenever possible to drive piles, and an impact hammer primarily used to proof load the piles to verify bearing load capacity, and not as the primary means to drive piles. When using the vibratory driver method, the distances at which the underwater noise thresholds occur would be reduced to 0.62 miles (1 km) for behavioral disruption. There are currently no criteria for injury to fish from vibratory pile driving (Table 4-1 and Figure 4-1).

All pile driving activities would be conducted during the allowable in-water work period, July 16 to February 15 to reduce potential impacts to fish. NBK Bangor fish surveys in the 1970s and 2005 to 2008 indicate that greater than 95 percent of the juvenile salmonids in this part of Hood Canal occur during the closure period (Schreiner et al. 1977; Salo et al. 1980; Bax 1983; SAIC 2006; Bhuthimethee et al. 2009). However, adult salmonids and other marine fish species occur in northern Hood Canal waters during the allowable in-water work period. In addition, some juvenile fish would similarly occur, and may be impacted by elevated underwater sound during construction activities. To help protect these fish, a soft-start approach (noise attenuator) would

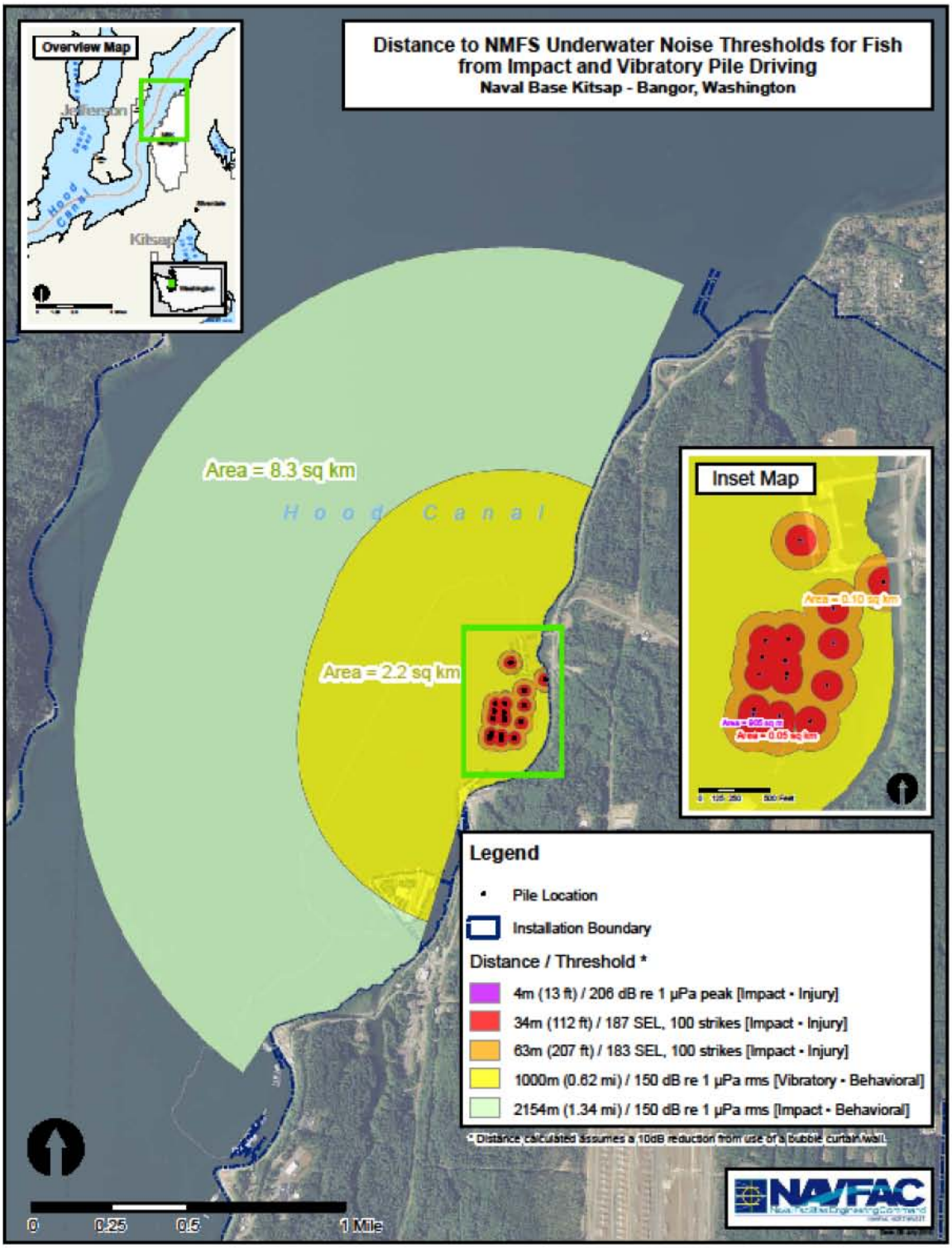

Figure 4-1. Distance to underwater noise thresholds for fish from impact and vibratory hammering occurring during the proposed Test Pile Program at NBK Bangor.

be used to allow time for fish to move away from the immediate project site, further reducing the number of fish potentially exposed to harmful levels of underwater sound.

4.1.2 Water Column

The primary potential impact to water column EFH, aside from the elevated noise levels, would be the result of the re-suspension of bottom sediments from pile installation and removal as well as barge and tug operations, such as anchoring and propeller wash. These changes would be spatially limited to the project site, including areas potentially impacted by anchor drag and areas immediately adjacent to the testing sites that could be impacted by plumes of re-suspended bottom sediments. These re-suspended bottom sediments could have an adverse affect on water column EFH through a variety of means, including an increase in turbidity, a reduction in the amount of DO present in the water, and re-suspension of contaminants formerly buried in the sediments.

During pile installation, bottom sediments, which may contain chemically reduced organic materials, would be re-suspended. Subsequent oxidation of sulfides, reduced iron, and organic matter associated with the suspended sediments would consume some DO in the water column. However, the impacts of sediment re-suspension from pile installation and removal on DO concentrations would be minimal. Additionally, a bubble curtain/wall would be used as mitigation for in-water sound during construction activities. Use of a bubble curtain/wall would increase DO concentrations in marine waters at the proposed project site by: 1) increasing the rate of vertical mixing of site waters; and 2) promoting dissolution of air bubbles, thereby increasing oxygen saturation levels. The impacts to DO from use of a bubble curtain would be relatively greater than those associated with sediment re-suspension, and a net increase in DO levels would be expected. Overall, the Test Pile Program would result in no measurable change to existing DO levels at the NBK Bangor waterfront or in Hood Canal in general. The proposed action would not result in violations of water quality standards for DO nor a local decrease in DO to a level impacting the health of fish.

An additional potential adverse impact to water quality from pile installation and removal is the potential release of sediment-bound metals and organic contaminants into the water column. However, sediments tested at NBK Bangor and the proposed project site contained low concentrations of metals and organic contaminants that fall below sediment quality guidelines (Foster Wheeler Environmental Corporation 2001; Hammermeister and Hafner 2009). Therefore, increases in chemical contaminant concentrations in marine waters as a result of sediment re-suspension during pile installation or removal operations would be minimal.

4.1.3 Benthic Habitats and Communities

The primary impact to benthic habitats designated as EFH would be the disruption of the epifauna/infauna associated with it. The barge anchors, spuds, and test piles would result in a

temporary loss of benthic habitat, as well as direct mortality of less motile benthic organisms. Indirect impacts to habitat and benthic organisms are likely to result from turbidity caused by driving and removing barge anchors, spuds, and the test piles. The area within a 150-foot radius of the pile driving footprint could have higher levels of turbidity. Disturbed sediments would eventually redeposit upon the existing benthic community. Suspension and surface deposit feeders would be the most susceptible to burial. However, these impacts are minor and temporary in nature. Benthic organisms, particularly annelids, are very resilient to habitat disturbance and are likely to recover to pre-disturbance levels within two years (CH2M Hill 1995; Parametrix 1994, 1999; Anchor Environmental 2002; Romberg 2005). During the pile driving period (40 days), juvenile salmonids and other marine fish species may experience a loss or reduction of available benthic prey at the project site due to the disturbance of pile installation, however, in-water work would occur during the time frame when few salmonids would be present, therefore adverse affect to benthic prey availability are not anticipated.

4.1.4 Marine Vegetation

Aquatic vegetation habitat is of principal concern to marine fish for foraging and refuge. Within the vicinity of NBK Bangor, a relatively narrow band of eelgrass and another consisting of kelp occur along nearly the entire shoreline (Morris et al. 2009) (Figures 3-3 and 3-4). Coverage by red and green algae throughout the study site is more extensive (Figure 3-4). Marine surveys at NBK Bangor have shown that eelgrass is only present in water down to 20 feet MLLW (Morris et al. 2009), which is well above the location of all but one test pile (Figure 3-3). With the exception of this single pile, all other test piles used during the study will be in waters deeper than 40 feet, thus eelgrass will be minimally impacted. None of the test piles will occur in close proximity to any of the kelp beds in the area. However, at least five of the piles will be installed directly within areas of containing red and green algae. The driving of the test piles will result in direct mortality of marine vegetation within the pile driving footprints, as well as indirect impacts resulting from the test piles, barge anchors, and spuds. These indirect impacts to marine vegetation are likely to occur from turbidity caused by pile driving, as well as the removal of barge anchors, spuds, and the test piles. The area within a 150-foot (46-m) radius of the pile driving footprints could have higher levels of turbidity. However, these impacts are minor and temporary in nature. Disturbed sediments would eventually redeposit and any disturbed marine vegetation will be expected to recover within a relatively short period of time.

4.2 ENVIRONMENTAL CONSEQUENCES

Designated EFH within the vicinity of the proposed Test Pile Program will be impacted in the following manner:

- Temporary disturbance and displacement of fish;
- Increased sediment loads and turbidity in the water column;

- Limited disruption of marine vegetation and benthic communities; and
- Temporary loss of benthic prey species to fish.

All of the effects above are either temporary or short-term, and would be further offset by the mitigations measures that will be set in place. As a result, the environmental impacts from the proposed Test Pile Program will have negligible to minor effects on designated EFH within the Hood Canal. The potential impacts to EFH are summarized in Table 4-2.

Table 4-2. Summary of potential impacts to EFH by impact type as a result of the proposed Test Pile Program.

Type of Impact	Temporary (Recovery: days to weeks)	Short Term (Recovery: < 3 years)	Long Term (Recovery: ≥ 3 to < 20 years)	Permanent (Recovery: ≥ 20 years)
Sound pressure levels	√			
Disruption to fish populations	√			
Disruption to benthic epifauna/infauna		√		
Disruption of aquatic vegetation		√		
Disruption of sediments	√			
Sedimentation/turbidity	√			

4.3 PROPOSED MITIGATION MEASURES AND GUIDELINES FOR EFH PROTECTION

The NMFS (2004) has developed a series of conservation measures pertaining to pile installation and removal that, if incorporated in project plans, would minimize impacts to EFH and marine fish species. Many of these measures, as well as several additional ones, have been incorporated into the design of the proposed Test Pile Program to reduce the overall level of impact. The mitigation measures to be implemented during the proposed project are as follows:

- *Vibratory Hammer Use* – All piles will be driven as deep as possible through the use of a vibratory hammer. Impact hammers will only be used to drive the pile the final 10 to 15 feet (3 to 4.6 m) and will be limited to 100 strikes per day. All piles will be removed through the use of a vibratory hammer, rather than the direct pull or clamshell methods, to reduce the amount of sediments suspended in the water column.
- *Sound Attenuation Devices* – Sound attenuation devices (e.g., bubble curtain, bubble wall, etc.) will be utilized during all impact pile driving operations. Impact pile driving is only expected to be required to "proof" or drive the last 10-15 ft of each pile. The Navy will also test the feasibility and effectiveness of using sound attenuation devices with vibratory hammers. The Navy will employ a bubble curtain/wall on two of the vibratory driven piles to

test the practicability of this concept and analyze the extent to which the air interface reduces the source energy level.

- *Acoustic Measurements* – Acoustic measurements will be used to empirically verify the proposed shutdown and buffer zones.
- *Timing Restrictions* - The Navy has set timing restrictions for pile driving activities to avoid in-water work when ESA-listed salmonid populations are most likely to be present. Therefore, all in-water work would occur only during the work window from July 15 through February 14 to minimize the number of fish exposed to underwater noise and other disturbance.
- *Soft Start* - Providing additional protection for marine fish, pile driving will include the use of a soft start as part of normal construction procedures. Depending on the type of impact hammer used, the soft start would consist of either a "ramp up" or a "dry-fire." Ramp-up involves slowly increasing the power of the hammer and noise produced over the ramp-up period. Specifically, NMFS requires that the first three initial hammer strikes are at less than full capacity (i.e., approximately 40 percent energy levels) with no less than a one minute interval between each strike, followed by two subsequent 3-strike sets (72 FR 25748). Likewise, "dry firing" of a pile driving hammer is a method of raising and dropping the hammer with no compression of the pistons, producing a lower-intensity sound rather than the full power of the hammer. In addition, if practicable, a soft start will also be used with vibratory installation. When vibratory hammers are used, the soft start requires that contractors initiate noise from the vibratory hammers for 15 seconds at reduced energy levels followed by a one minute waiting period. This procedure would be repeated two additional times. This will allow marine fish the opportunity to leave the area prior to the hammer operating at full capacity.
- *Daylight Construction* – Pile driving will only be conducted during daylight hours.

5.0 CONCLUSIONS

The primary impact during the proposed Test Pile Program will be the level of increased sound energy in the water. The effects to fish caused by the increased noise levels include disturbance, avoidance, injury, and even death. The level of impact is directly proportionate to the distance between the fish and the sound source. The Navy has adopted a number of mitigation measures and operational guidelines to reduce the level of impact pile driving operations will have on marine fish in the vicinity. Because the piles being driven are hollow steel piles, in accordance with the conservation measures set forth by NMFS (2004), the Navy will use a vibratory hammer to drive each pile into the sediment to the deepest extent possible. However, due to the need to ensure the stability of the test piles while conducting the load bearing tests, each pile will be

driven the final 10 to 15 feet using an impact hammer. To limit the amount of ensonification of the water resulting from the impact hammering, a sound attenuation device (e.g., bubble curtain or bubble wall) will be utilized during all impact hammering operations to reduce the transmission of the sound through the water column. Furthermore, the use of impact hammers will be limited to 100 strikes per day. In addition to these measures, all work will be limited to the in-water work window of July 15 through February 14 when juvenile salmon are not typically present within the vicinity of the proposed project site. These measures, in conjunction with the short duration of the proposed project (40 days) should greatly reduce the impact of the noise levels as a result of the pile driving activities.

The installation and subsequent removal of the piles, along with the activities associated with barge anchoring and spuds, will have a localized impact on marine vegetation and the benthic epifauna/infauna within the immediate vicinity of each pile or anchoring site. However, to minimize impacts to marine vegetation, all of the test piles have been placed to avoid eelgrass and kelp beds along the NBK Bangor waterfront. While some disruption to marine vegetation and benthic communities is unavoidable as a result of the placement and recovery of the test piles, barge anchoring, and associated sedimentation, these impacts will be temporary in duration, with a minimal and localized zone of influence. Areas of disruption are expected to recover to pre-disruption levels within a single growing season.

The water column may experience increased sedimentation and turbidity during operational periods. However, due to the relatively low levels of organic contaminants and metals contained within the sediments at NBK Bangor, there will be temporary and minimal degradation of the water column, with little to no impact on DO levels in the vicinity of the proposed project site.

Overall, due to the temporary nature of the activities and the minimal level of impact, in light of the proposed mitigation measures and work guidelines for the project, the activities associated with the proposed Test Pile Program will not have an adverse affect on designated EFH or marine fish species within the vicinity of NBK Bangor and Hood Canal.

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APPENDIX

Essential Fish Habitat Designations by Species and Lifestage for Pacific Coast Groundfish Based on the Pacific Fishery Management Council's Habitat Use Database

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor.

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Sharks, Rays, & Skates				
Big skate (*Raja binoculata*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Eggs	Benthos	Unconsolidated	Unknown
	Juveniles	Benthos	Unconsolidated	Unknown
Longnose skate (*Raja rhina*)	Adults	Benthos	Unconsolidated	Unknown
Spiny dogfish (*Squalus acanthias*)	Adults	Benthos	Unconsolidated	Mud
		Intertidal Benthos	Unconsolidated	Mud
		Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Unconsolidated	Mud
		Intertidal Benthos	Unconsolidated	Mud
		Water Column	Epipelagic Zone	Unknown
Ratfish				
Spotted ratfish (*Hydrolagus colliei*)	Adults	Benthos	Hard Bottom	Bedrock
				Cobble
			Unconsolidated	Mud
	Eggs	Benthos	Hard Bottom	Bedrock
				Gravel/Cobble
			Unconsolidated	Sand
	Juveniles	Benthos	Hard Bottom	Bedrock
				Gravel/Cobble
			Unconsolidated	Mud
Roundfish				
Cabezon (*Scorpaenichthys marmoratus*)	Adults	Benthos	Hard Bottom	Bedrock
				Cobble
				Unknown
			Unconsolidated	Sand
			Vegetated Bottom	Algal Beds/Macro
				Rooted Vascular
		Intertidal Benthos	Tide Pool	Unknown
	Eggs	Benthos	Hard Bottom	Unknown
			Vegetated Bottom	Algal Beds/Macro
	Juveniles	Benthos	Hard Bottom	Bedrock
			Vegetated Bottom	Algal Beds/Macro

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Roundfish (continued)				
Cabezon (*Scorpaenichthys marmoratus*)	Juveniles	Intertidal Benthos	Tide Pool	Unknown
		Water Column	Epipelagic Zone	Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Kelp greenling (*Hexagrammos decagrammus*)	Adults	Benthos	Hard Bottom	Bedrock
				Unknown
			Vegetated Bottom	Algal Beds/Macro
	Eggs	Benthos	Hard Bottom	Unknown
			Vegetated Bottom	Algal Beds/Macro
	Juveniles	Benthos	Hard Bottom	Bedrock
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Lingcod (*Ophiodon elongatus*)	Adults	Benthos	Hard Bottom	Bedrock
				Boulder
			Vegetated Bottom	Algal Beds/Macro
				Rooted Vascular
	Eggs	Benthos	Hard Bottom	Bedrock
	Juveniles	Benthos	Unconsolidated	Gravel
				Mud
				Sand
	Larvae	Water Column	Epipelagic Zone	Unknown
Pacific whiting/hake (*Merluccius productus*)	Adults	Water Column	Epipelagic Zone	Unknown
	Juveniles	Water Column	Epipelagic Zone	Unknown
Sablefish (*Anoplopoma fimbria*)	Adults	Benthos	Unconsolidated	Mud
	Eggs	Water Column	Epipelagic Zone	Unknown
	Juveniles	Water Column	Epipelagic Zone	Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Rockfish				
Black rockfish (*Sebastes melanops*)	Adults	Benthos	Artificial Structure	Artifical Reef
			Hard Bottom	Bedrock
				Boulder
			Vegetated Bottom	Algal Beds/Macro
				Rooted Vascular

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Rockfish (continued)				
Black rockfish (*Sebastes melanops*)	Adults	Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
	Juveniles	Benthos	Artificial Structure	Artifical Reef
			Hard Bottom	Bedrock
				Boulder
			Tide Pool	Unknown
			Vegetated Bottom	Algal Beds/Macro
				Rooted Vascular
		Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
Blue rockfish (*Sebastes mystinus*)	Adults	Benthos	Hard Bottom	Bedrock
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
	Juveniles	Benthos	Hard Bottom	Bedrock
		Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Bocaccio (*Sebastes paucispinis*)	Juveniles	Benthos	Hard Bottom	Bedrock
		Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Brown rockfish (*Sebastes auriculatus*)	Adults	Benthos	Artificial Structure	Artifical Reef
			Hard Bottom	Bedrock
				Boulder
			Mixed Bottom	Sand/Rock
			Vegetated Bottom	Rooted Vascular
	Juveniles	Benthos	Hard Bottom	Bedrock
				Boulder
				Cobble
			Vegetated Bottom	Algal Beds/Macro
				Rooted Vascular
		Water Column	Epipelagic Zone	Unknown

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Rockfish (continued)				
China rockfish (*Sebastes nebulosus*)	Adults	Benthos	Hard Bottom	Bedrock
				Boulder
				Cobble
			Vegetated Bottom	Algal Beds/Macro
		Unknown	Unknown	Unknown
	Juveniles	Benthos	Hard Bottom	Unknown
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Unknown
Copper rockfish (*Sebastes caurinus*)	Adults	Benthos	Artificial Structure	Artifical Reef
			Hard Bottom	Bedrock
				Boulder
			Mixed Bottom	Sand/Rock
			Vegetated Bottom	Algal Beds/Macro
	Juveniles	Benthos	Hard Bottom	Bedrock
				Cobble
			Mixed Bottom	Sand/Rock
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Drift Algae
				Macrophyte Canopy
				Unknown
Quillback rockfish (*Sebastes maliger*)	Adults	Benthos	Artificial Structure	Artifical Reef
			Mixed Bottom	Mud/Cobble
			Vegetated Bottom	Algal Beds/Macro
	Juveniles	Benthos	Biogenic	Sponges
			Hard Bottom	Unknown
			Mixed Bottom	Sand/Rock
			Vegetated Bottom	Algal Beds/Macro
				Drift Algae
				Rooted Vascular
	Larvae	Water Column	Epipelagic Zone	Unknown
Redstripe rockfish (*Sebastes proriger*)	Adults	Benthos	Hard Bottom	Unknown
		Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Hard Bottom	Unknown
			Mixed Bottom	Sand/Rock

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Rockfish (continued)				
Redstripe rockfish (*Sebastes proriger*)	Juveniles	Water Column	Epipelagic Zone	Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Silvergray rockfish (*Sebastes brevispinis*)	Adults	Benthos	Hard Bottom	Bedrock
				Boulder
Splitnose rockfish (*Sebastes diploproa*)	Juveniles	Water Column	Epipelagic Zone	Drift Algae
				Macrophyte Canopy
				Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Tiger rockfish (*Sebastes nigrocinctus*)	Adults	Benthos	Hard Bottom	Bedrock
				Boulder
		Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Hard Bottom	Bedrock
		Water Column	Epipelagic Zone	Drift Algae
				Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Widow rockfish (*Sebastes entomelas*)	Adults	Benthos	Hard Bottom	Bedrock
			Mixed Bottom	Mud/Rock
		Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Hard Bottom	Bedrock
			Unconsolidated	Unknown
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Macrophyte Canopy
				Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Yelloweye rockfish (*Sebastes ruberimus*)	Adults	Benthos	Hard Bottom	Bedrock
				Boulder
			Mixed Bottom	Mud/Boulders
	Juveniles	Benthos	Biogenic	Sponges
			Hard Bottom	Bedrock
	Larvae	Water Column	Epipelagic Zone	Unknown
Yellowtail rockfish (*Sebastes flavidus*)	Adults	Benthos	Hard Bottom	Bedrock
			Unconsolidated	Sand
			Vegetated Bottom	Algal Beds/Macro

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Rockfish (continued)				
Yellowtail rockfish (*Sebastes flavidus*)	Juveniles	Benthos	Hard Bottom	Bedrock
			Unconsolidated	Sand
			Vegetated Bottom	Algal Beds/Macro
		Water Column	Epipelagic Zone	Unknown
Flatfish				
Butter sole (*Isopsetta isolepis*)	Adults	Benthos	Unconsolidated	Mud
				Sand
	Eggs	Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Unconsolidated	Mud
				Sand
	Larvae	Water Column	Epipelagic Zone	Unknown
English sole (*Parophrys vetulus*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Eggs	Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
Flathead sole (*Hippoglossoides elassodon*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
Pacific sanddab (*Citharichthys sordidus*)	Adults	Benthos	Mixed Bottom	Sand/Gravel
				Sand/Rock
			Unconsolidated	Mud
				Sand
	Eggs	Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Mixed Bottom	Silt/Sand
			Unconsolidated	Sand
	Larvae	Water Column	Epipelagic Zone	Unknown
Petrale sole (*Eopsetta jordani*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand

Table A-1. Species and lifestages belong to the Pacific coast groundfish management unit with EFH designated in the vicinity of Hood Canal and the Naval Base Kitsap Bangor (continued).

Species	Lifestage	Habitats Designated for Inland Seas (Puget Sound)		
		Level 2	Level 3	Level 4
Flatfish (continued)				
Petrale sole (*Eopsetta jordani*)	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
Rex sole (*Glyptocephalus zachirus*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
Rock sole (*Lepidopsetta bilineata*)	Adults	Benthos	Unconsolidated	Gravel
				Mixed mud/sand
				Sand
	Eggs	Benthos	Unconsolidated	Sand
	Juveniles	Benthos	Mixed Bottom	Sand/Gravel
			Unconsolidated	Gravel
				Mixed mud/sand
				Sand
	Larvae	Water Column	Epipelagic Zone	Unknown
Sand sole (*Psettichthys melanostictus*)	Adults	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Eggs	Water Column	Epipelagic Zone	Unknown
	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
		Water Column	Epipelagic Zone	Unknown
	Larvae	Water Column	Epipelagic Zone	Unknown
Starry flounder (*Platichthys stellatus*)	Adults	Benthos	Unconsolidated	Gravel
				Mixed mud/sand
				Mud
				Sand
	Eggs	Water Column	Epipelagic Zone	Seawater surface
	Juveniles	Benthos	Unconsolidated	Mixed mud/sand
				Mud
				Sand
	Larvae	Water Column	Epipelagic Zone	Unknown